

Boeing Defense & Space Group

Pitfalls to Avoid in Power Supply Specifications

Information & Electronic Systems Division

**June 23, 1997
Presented to
Electronic Power Specification Standard
Working Group**

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REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
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1. REPORT DATE (DD-MM-YYYY) 23-06-1997		2. REPORT TYPE Briefing		3. DATES COVERED (FROM - TO) xx-xx-1997 to xx-xx-1997	
4. TITLE AND SUBTITLE Pitfalls to Avoid in Power Supply Specifications Unclassified			5a. CONTRACT NUMBER		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) Mehdi, Ishaque S. ;			5d. PROJECT NUMBER		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME AND ADDRESS Boeing Defense & Space Group XXXXX XXXXX, XXXXXXXX			8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING/MONITORING AGENCY NAME AND ADDRESS Open Systems Joint Task Force (OSJTF) 1931 Jefferson Davis Highway Crystal Mall 3, Suite 104 Arlington, VA22202			10. SPONSOR/MONITOR'S ACRONYM(S)		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION/AVAILABILITY STATEMENT APUBLIC RELEASE ,					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT See Report.					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:		17. LIMITATION OF ABSTRACT Public Release	18. NUMBER OF PAGES 19	19. NAME OF RESPONSIBLE PERSON http://www.acq.osd.mil/osjtf/library/library_alpha.html (blank) lfenster@dtic.mil	
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified	19b. TELEPHONE NUMBER International Area Code Area Code Telephone Number 703767-9007 DSN 427-9007		
				Standard Form 298 (Rev. 8-98) Prescribed by ANSI Std Z39.18	

Electronic Power Specification Standard Agenda

- **Performance Requirements**
- **Packaging Constraints**
- **Environmental Requirements**
- **Qualification Requirements**

Electronic Power Specification Standard Performance Requirements

- **Do not include bells and whistles in the specification that the customer has no intention of using in the end item**
 - **For example: TM Bus, Thermal Sensors, Monitor Discrete Status Signals, etc.**
 - **TM Bus requires custom ASIC, special autotest software, uses 15% of overall volume and dissipates 5 watts maximum**
- **Don't require DHMR&D diagnostic and health management requirements**
- **Minimize EMI, Common Mode Current, ESD, input power distortion spectrum and EMP requirements**
- **Reduce status I/O to minimum Go/No Go**
 - **More complex status circuits increase risks for noise problems**
- **Define nature of loads**
 - **Number one factor in most design decisions**

Electronic Power Specification Standard 270V Power Supplies

Input	Subsystem	Converter Type	Output
270V	Power Conditioner		270V used with CNI/EW and CIP
270V	CNI/EW	Buck/Push-pull	+5V or +5.2V/250W
270V	CNI/EW	Buck/Push-pull	+15V/250W
270V	CNI/EW	Buck/Push-pull	+48V/250W
270V	CNI/EW	Buck/Push-pull	+9V/120W, +15W/90W
270V	CNI/EW	Buck/Push-pull	+5.2V/105W, +15V/90W
270V	CIP LFT	Buck/Push-pull	+5V or +5.2V/400W
28V	VMS/SMS/IVSC	Buck/Boost-capacitive idling	+5V/60W, +15V/50W, -15V/40W, 100W total limitation

Electronic Power Specification Standard Low Noise (Linear) Power Supplies

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Type (User)	Input				Output		
	Nominal Voltage (DC)	Volt. Tolerance Worst Case at Full Load (mVDC)	Voltage Tolerance at 10% Load (mVDC)	Current (amperes)	Nominal Voltage (DC)	Voltage Tolerance Worst Case (mVDC)	Current (amperes)
VR #1 Analog (RSE)	+19.373	±223	±223	18.8	+18.3	±300	18.8
	-20.8	±1700	-5380 +1750	1.2	-18.2	±300	1.2
VR #2 Analog (RSE)	+8.231	±381	±381	18.8	+7.1	±200	17.1
	-8.331	±381	-2063 +381	12.1	-7.2	±200	12.1
VR #3 Analog (RSE)	+6.450	±550	+2063 -550	18.8	+5.1	±150	6.25*
	-6.421	±421	-2063 +421	23.3	-5.3	±150	23.3
VR #4 Analog (RSE)	+6.236	±386	±386	55.5	+5.15	±100	55.5**
	-6.361	±361	-1858 +361	8.1	-5.3	±150	8.1
VR #5 Analog (RFR)	+8.575	±725	+3225 -725	9.2	+7.1	±200	9.2**
	-13.890	±890	-3695 +890	6.6	-12.1	±350	6.6
VR #6 Analog (RFR)	+13.250	±200	±200	19.4	+12.1	±350	19.4

* Includes current (0.75A) to power Time Stress Management Devices (TSMDs) on three Voltage Regulators (VRs)

** Includes current (0.5A) to power TSMDs on two VRs

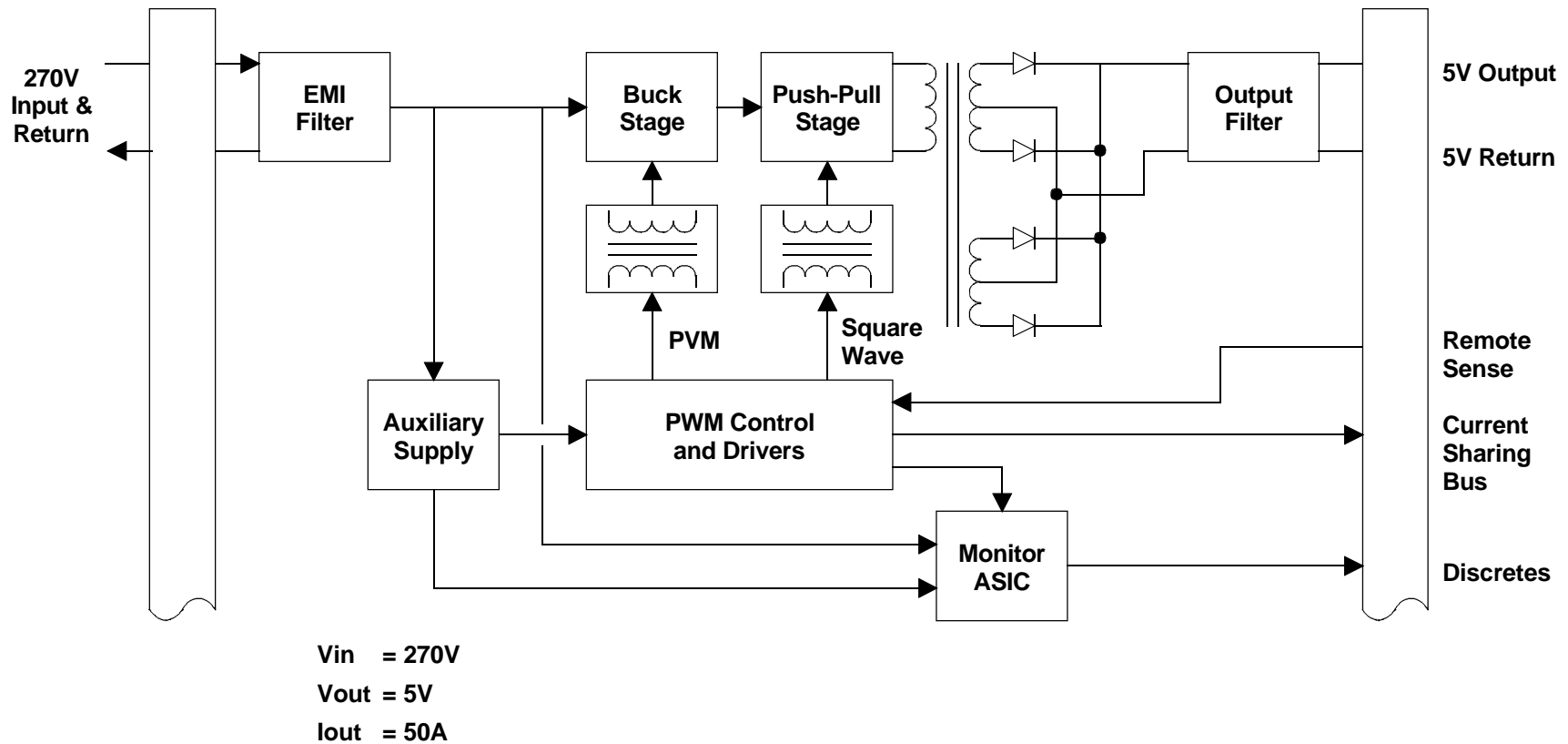
Electronic Power Specification Standard Commercial Power Supplies

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Input Voltage	LRU	Converter Type	Power Level Watts	-15V	-12V	-9V	-5V	+5V	+6V	+12V	+5Gnd	+5Mem	+15V
28VDC	FSEU PSU	Flyback	45.5	0.75				4.5			0.1		0.75
	C/F PSU	Fwd Converter	255.0	6.0				15.0					6.0
	MD&T, MDC	Flyback	34.0					2.0		2.0			
	OPAS (OPMC)	Flyback	10.0					2.0					
	OPAS (OPAC)	Flyback	46.5	1.2				2.0			0.1		1.2
	OPAC (DCU)	Flyback	46.0	1.2				2.0					1.2
	CSC	Flyback	9.5	0.06				1.27					0.15
28VDC	RTP	Flyback	5.4	0.05			0.015	0.774					0.05
115VAC	ZMU	Flyback	47.0	0.023		0.58		5.9	0.29	0.23		0.76	0.25
115VAC	EMC	Flyback	36.0	0.4		0.225		3.5	0.675	0.37		0.33	
115VAC	CACP	Flyback	44.5					4.1		1.993			
115VAC	CSMU	Flyback	50.5	0.525		0.569		5.25		0.058		0.529	0.525
115VAC	CSCP	Forward	70.0					8.7		2.2			
28VDC	CI	Flyback	18.6	0.2		0.18		1.6					0.4
28VDC	CI-ZMU	Flyback	6.4	0.01				0.8					0.15
28VDC	PAC	Flyback	24.0	0.23		0.18		2.2					0.53
28VDC	SDM	Flyback	4.4	0.06				0.5					0.065
	PCP	Flyback	4.2	0.01				0.5					0.1
150VDC	SEU	Forward	18.2		0.18			0.7	1.5	0.26			
115VAC	OEU		1.2				0.006	0.23					
115VAC	CSEU	Forward		0.52				10.6					0.65
28VDC	737 EGADS	Forward	25.0		0.750			1.0		0.750			
115VAC	WEU	Forward	27.0		1.0			2.9		1.25			
115VAC	CCP	Forward	33.0		0.1			4.0		0.1		0.25	

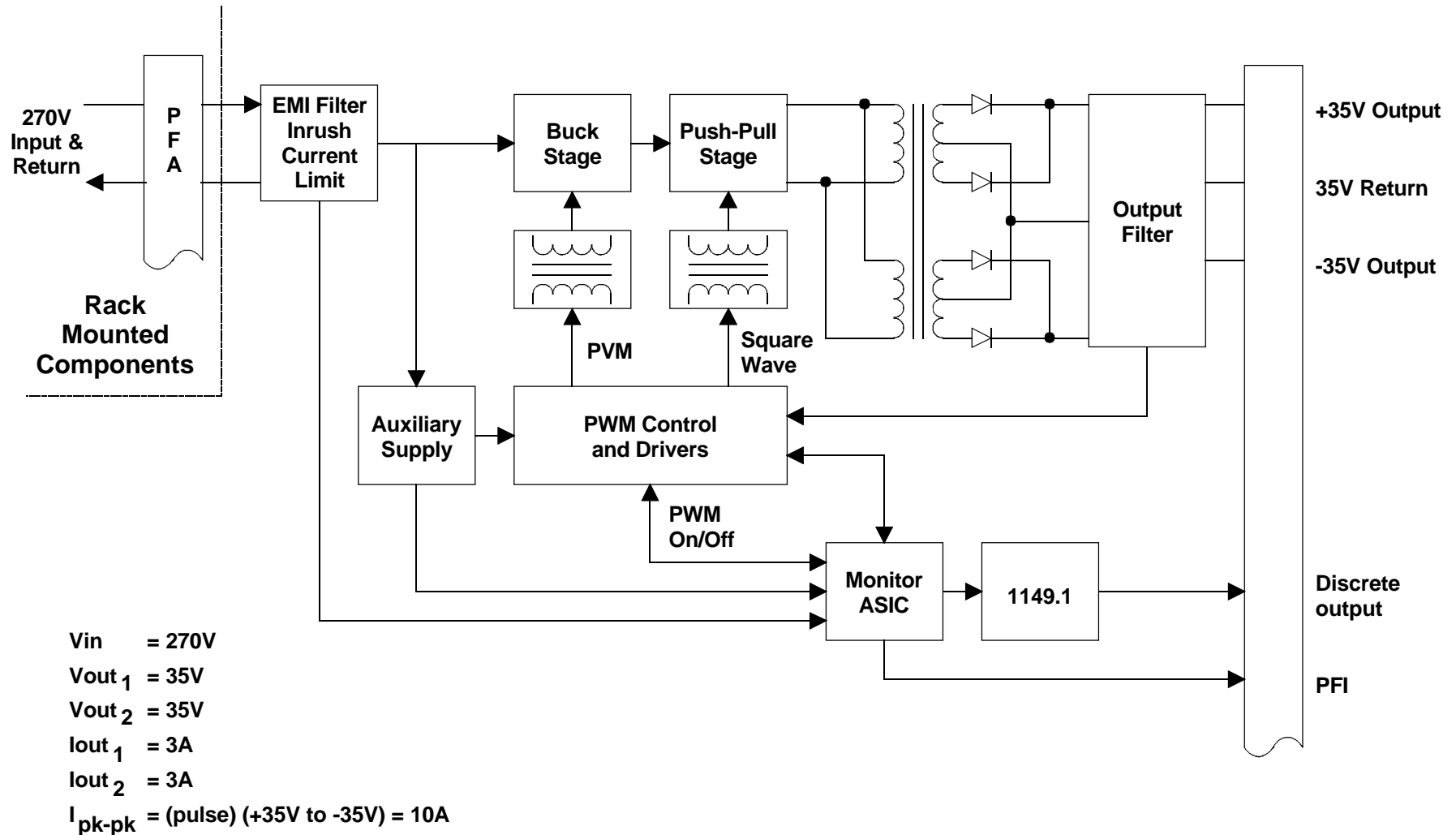
Electronic Power Specification Standard 5VDC Power Supply Module Block Diagram

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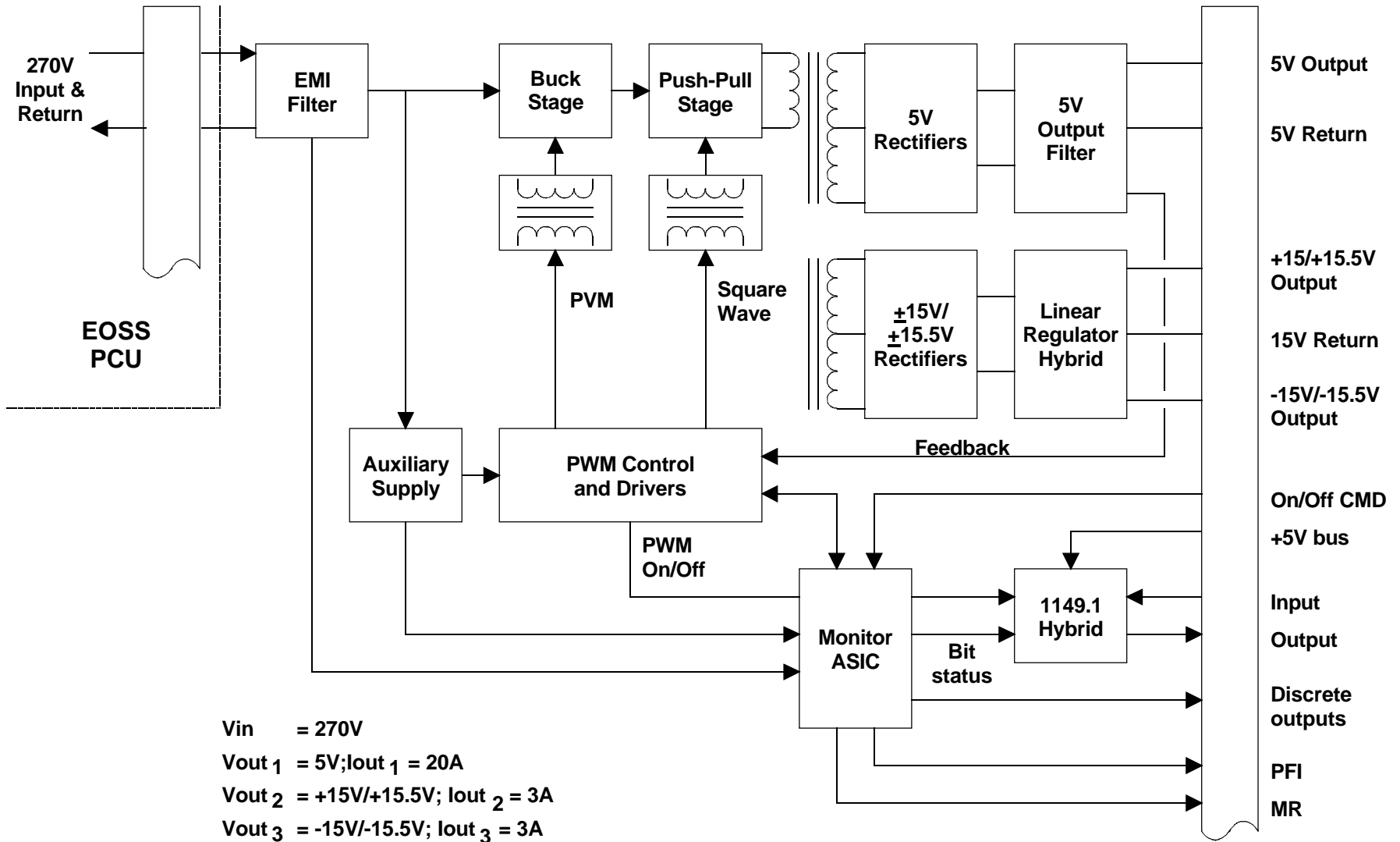
Electronic Power Specification Standard Functional Overview $\pm 35V$ Output Block Diagram

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Electronic Power Specification Standard Triple Output Block Diagram

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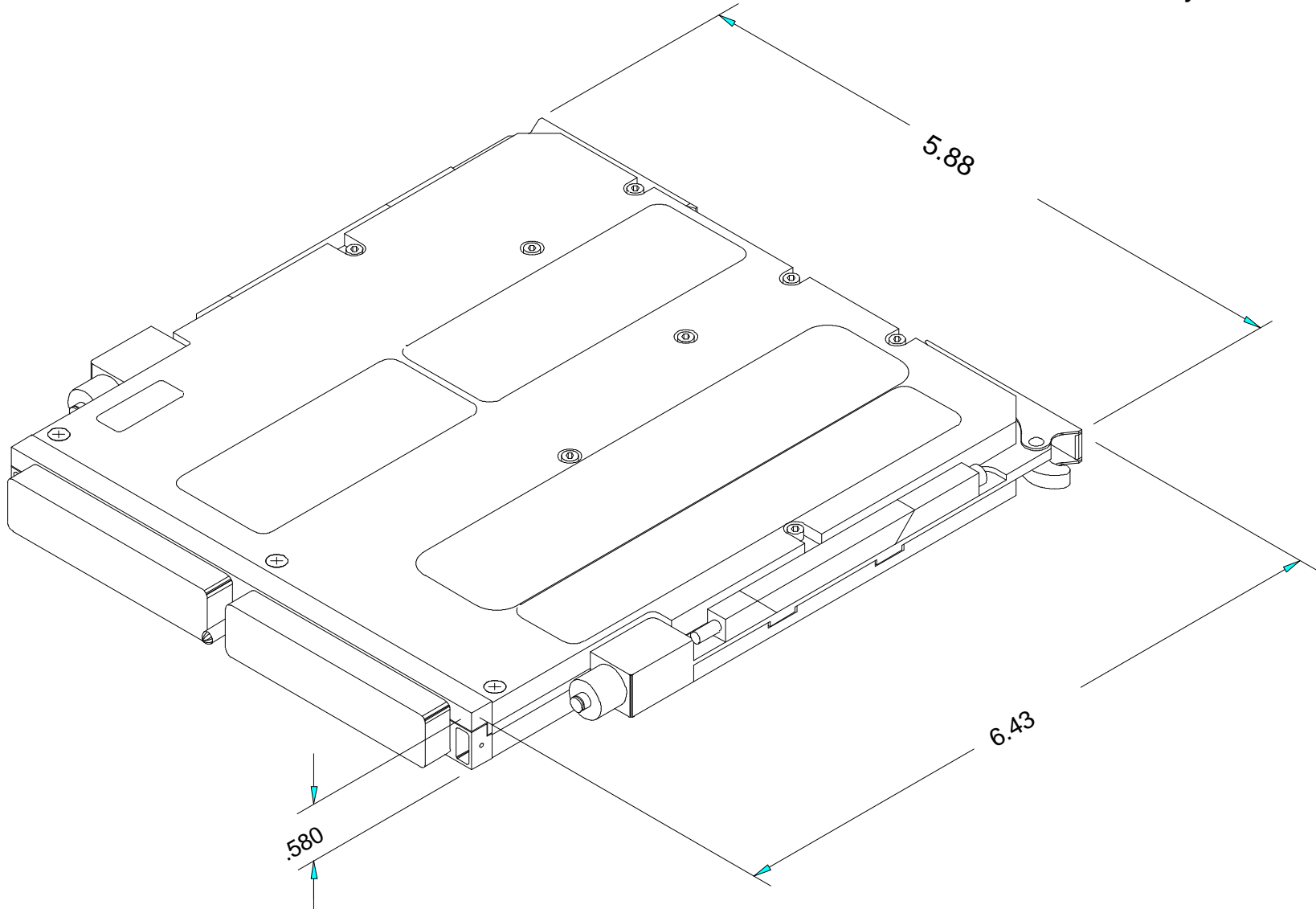


Electronic Power Specification Standard Packaging Constraints

- **SEM-E Format - Length and width OK, but height of 0.6 in. is a challenge, prefer double height (1.2 in.) for magnetics**
- **Mil Spec parts have long lead times. Industrial/commercial grade more readily available**
- **Avoid NSPARs and go with best available parts. Testing, screening, qualification of parts offers little benefit**
- **Make sure commercial parts are well defined to avoid NSPARs and SCDs**
- **Accept vendor drawings for Hybrids instead of requiring SCD control**
- **Avoid costly platings/finishes. Finishes should be consistent/compatible with overall system specification**

SEM-E Format

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Electronic Power Specification Standard Packaging Options

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Packaging Option	Parts	Operating Temperature	Vibration	Shock	Altitude (operating)	Humidity	Salt Fog/ Conformal Coat
Conduction Cooled IEEE 1101.2 for ATR	Hermetic, premium quality	-55C to 85C	0.1g ² /Hz	40g 11ms	50,000 ft.	Aggravated	Yes
Conduction Cooled IEEE 1101.2 for ATR	Industrial grade	-40C to 65C	0.1g ² /Hz	40g 11ms	50,000 ft.	Aggravated	Yes
Conduction Cooled IEEE 1101.2 for ATR	Commercial grade	-20C to 55C	0.1g ² /Hz	40g 11ms	50,000 ft.	Aggravated	Yes
Convection Cooled IEEE 1101.1 for Rugged Enclosure	Hermetic, premium quality	-55C to 85C	5g	30g 11ms	50,000 ft.	Aggravated	Yes
Convection Cooled IEEE 1101.1 for Rugged or Commercial Enclosure	Industrial grade	-40C to 85C	5g	30g 11ms	50,000 ft.	Aggravated	Yes
Convection Cooled IEEE 1101.1 for Development Enclosure	Commercial grade	0C to 55C	5g	30g 11ms	15,000 ft.	95% non- condensing	No

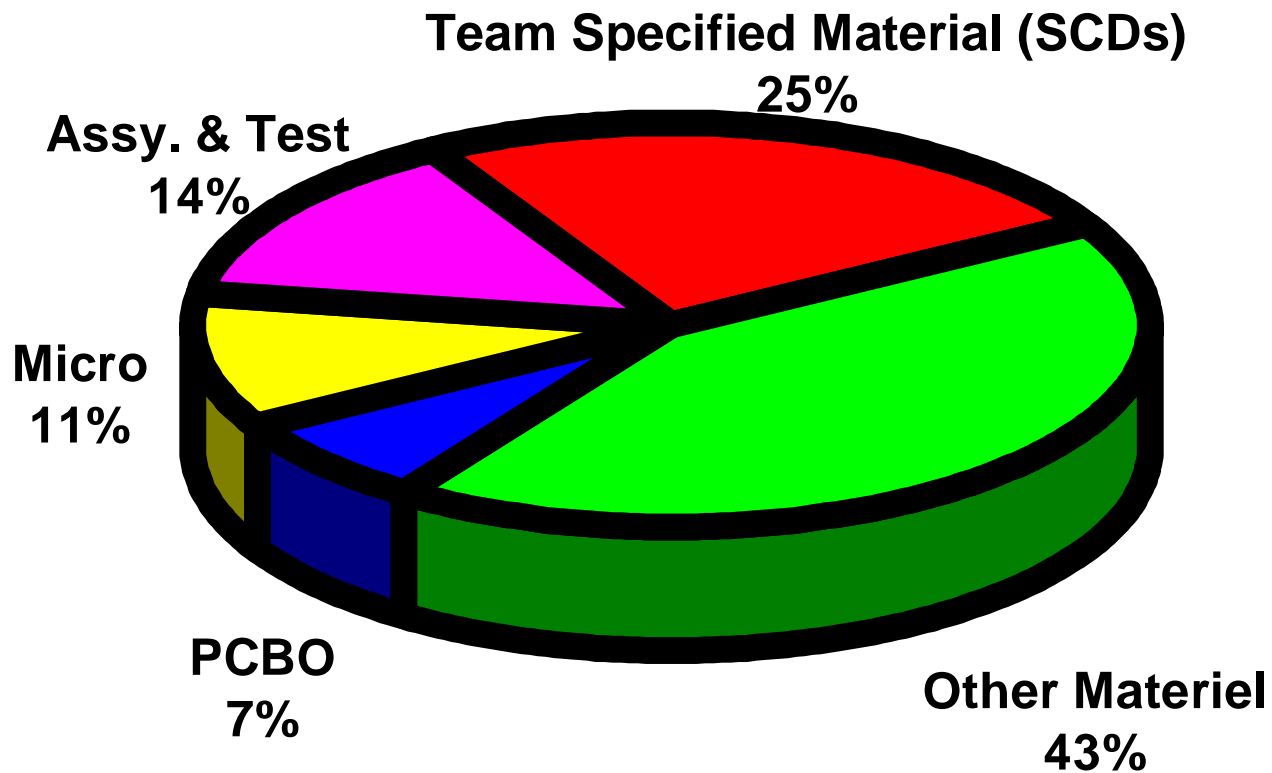
Electronic Power Specification Standard Packaging Unit Cost Options

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Packaging Option	Typical Processor CPU-601 (Qty = 10 to 24)	Typical Memory SME-2 (Qty = 10 to 24)	Typical I/O EMPP-1 (Qty = 10 to 24)
Conduction Cooled IEEE 1101.2 for ATR (MI Style)	\$51,000	\$22,000	\$15,200
Conduction Cooled IEEE 1101.2 for ATR (RI Style)	\$38,000	\$17,900	\$13,000
Conduction Cooled IEEE 1101.2 for ATR (EI Style)	\$14,200	\$6,700	\$8,000
Convection Cooled IEEE 1101.1 for Rugged Enclosure (MA Style)	\$50,500	\$21,300	\$14,500
Convection Cooled IEEE 1101.1 for Rugged or Commercial Enclosure (R Style)	\$37,000	\$16,800	\$12,000
Convection Cooled IEEE 1101.1 for Development Enclosure (E Style)	\$12,200	\$5,100	\$6,500

Electronic Power Specification Standard 5V SEM-E Power Supply DTC

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Electronic Power Specification Standard Materiel Estimate for 5 Volt Power Supply

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Part Type	Standard	SCD	Total
Monitor ASIC DIE/MCN DIE		26% 26%	
Capacitors 0.3%	12%	12%	
Headers	9.9%	9.9%	
Frame/Core	9.4%	9.4%	
Connector	8.3%	8.3%	
Transformers	7.9%	7.9%	
Diodes 2.2%	4.6%	6.8%	
Resistors 0.7%	3.5%	4.3%	
ICs 4.3%	4.3%		
Inductors	3.5%	3.5%	
Covers	3.0%	3.0%	
Injector/Ejector	1.4%	1.4%	
Jumper, polyimide, ink, nuts, screws, washers, wedgeclamps	1.6%	1.9% 3.5%	transistors,
Total 4.8% 95%	100%		

Electronic Power Specification Standard Packaging Constraints (continued)

- **Use off-the-shelf wedge-locks, extractors, hardware**
- **Use off-the-shelf connectors**
- **Avoid flow-through cooling**
- **For flow-through cooling, select non-hazardous coolant, leak proof fittings**
- **Don't require Mil-Std-2000A - Replace with IPC specifications**
- **Define power supply space/volume with equal priority to rest of system**
 - **Remaining or left-over space becomes expensive packaging technology**
 - **The smaller the size, the greater the cost**

Electronic Power Specification Standard Environmental Requirements

- **Specify actual operating environment with some degree of safety margin**
- **Motherhood specifications that cover worst-case conditions increase package complexity and cost**

Electronic Power Specification Standard Qualification Requirements

- **Qual test should be representative of operational environment**
- **Do not require Integrity Analysis**
 - **Costly with little benefit**

Electronic Power Specification Standard Summary

- **Listen to industry**
- **Group design decisions are costly without total concurrence**
- **Specify end item performance without specifying how to build it**